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PLANT PATHOLOGY SEED POTATO EXPERIMENTS

POTATO DISEASES IN NEW JERSEY

Mel. T. Cook. Indispensable.

NEW BRUNSWICK, N. J.

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NEW JERSEY

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CIRCULAR 105

Potato Diseases in New Jersey*

Potato growing is one of the most important industries in New Jersey. In 1915 there were 93,000 acres in potatoes producing 12,090,000 bushels, or an average of 130 bushels per acre. This crop is valued at $97.50 per acre, or $9,068,000 for the entire crop (U. S. Monthly Crop Report, Dec. 30, 1915). However, the industry suffers very heavy annual losses, which are due primarily to three causes: poor seed, unfavorable weather, insects and diseases. The weather conditions are beyond our control, except where methods of cultivation may help to conserve the moisture or where irrigation can be used to advantage. The most injurious insects are quite readily controlled, but the methods may be improved as the result of future experimental work. The seed can be improved by proper selection. The diseases caused by fungi and bacteria are much more difficult to control and are the causes of the greater part of our losses. A conservative estimate of the annual losses in New Jersey potato production due to fungous and bacterial diseases will range from 10 per cent to 25 per cent. Many of these losses could be prevented by the proper selection and treatment of seed and by the proper treatment of the growing crops.

ROTS

Seed potatoes are often affected with soft rots, which may be due to any one of several causes. The most important, to the potato growers of New Jersey, is due to bacteria which

*Prepared January 1, 1919, by Mel T. Cook, Ph.D., Plant Pathologist of the New Jersey Agricultural Experiment Station, to supercede Circulars 33, 53 and 95.

cause a rapid rotting of the tubers (fig. 1). The soft, slimy pulp, containing millions of bacteria, is smeared over the surface of the sound potatoes in the handling, and some of it reaches the freshly cut surfaces by contact with the potatoes or from the cutting knife. If the cut potatoes stand for a short time before planting, black sunken spots, due to the action of the bacteria, appear on the cut surfaces. If the weather is warm the potato sprouts, and no great loss results from this rot. But if the weather is cold and wet many of the seed pieces rot, the result being a poor stand or weak plants. This rot was especially destructive in 1913.

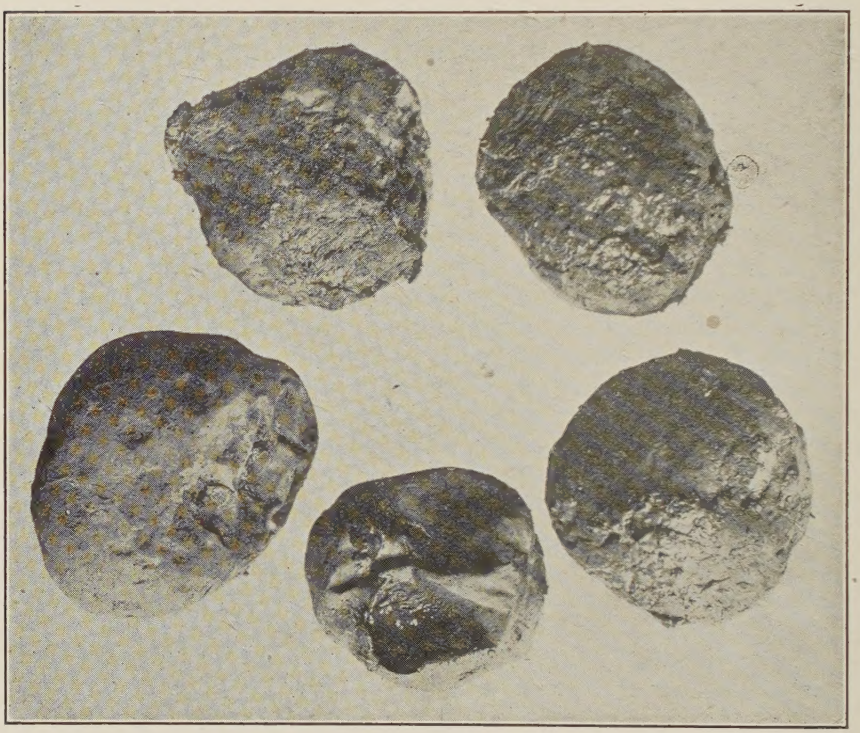

FIG. 1. BACTERIAL ROT OF SEED POTATOES

Control.—Although the weather is the most important factor in the control of this trouble, the loss can be reduced by treatment of the seed with formaldehyde or corrosive sublimate, and by dipping the cutting knives in a 25 per cent solution of formaldehyde (see page 33). This may be easily accomplished by having two knives for each cutter and letting one stand in the

solution while the other is being used. This precaution has been adopted by many of the northern growers. It is also advisable to treat the cut seed with sulfur (see page 34).

Other soft rots due to black leg (*Bacillus phytophthorus*), to late blight (*Phytophthora infestans*), and to various other fungi (*Rhizopus nigricans,* etc.) are frequently present (see pages 5, 15).

SOUTHERN BACTERIAL WILT

This disease, also known as the "sleeping sickness," is caused by *Bacillus solanacearum,* E. F. Smith. It attacks potatoes, tomatoes, eggplants, peppers and tobacco (on which it is known as the Granville tobacco wilt), and is one of the most destructive diseases of the southern states. It was reported in 1903 as attacking tomatoes in this state. It is especially severe in dry seasons and on dry soils. It was very severe on the potatoes in the southern part of the state in 1913, and aside from weather conditions caused greater injury to the early Cobblers than any other one factor. The disease was decidedly more severe on potatoes grown from eastern seed than on those from New Jersey grown seed, and there was a slight amount of evidence tending to show that it was less severe on seed which had been treated with formaldehyde than on seed which had not been treated. The evidence on this point is, however, far from conclusive. It was severe as far north as Burlington, and of very little importance north of this point.

The disease first appears as a wilting, followed by a revival at night and a wilting on the second day. Plants very seldom survive the second day's wilting unless there should be intervening rains, but become yellow and blacken, and the tubers rot readily. The disease is carried by insects and in the seed, and in the southern states in the soil. It is probable that the cold weather of the north checks it to some extent, but this point has not been conclusively demonstrated.

Control.—Tubers from diseased vines should not be used for seed, and rotation of crops should be practiced. Other crops which are attacked by the disease should not be used in the rotation.

BLACK LEG

This is one of the severe diseases of the potato which comes to us in seed, and is the cause of heavy losses throughout the state every year.

It is a bacterial disease (*Bacillus phytophthorus* Appel) and probably came to us from Europe. The affected plants are

under-sized and very erect; the leaves are pale in color and tend to curl upward (fig. 2). The stems die from the seed piece upward, turn black and become dry. We have no reason to believe that the organism causing the disease will persist from year to year in our New Jersey soils. The disease is always much more severe on crops grown from northern seed than on crops grown from second crop seed.

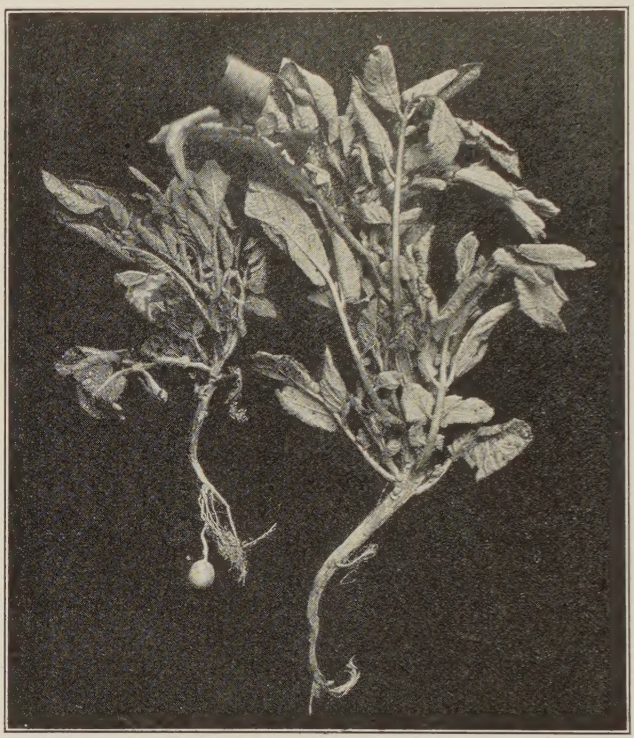

FIG. 2. BLACK LEG

The disease also causes a rotting of the tubers (fig. 3), beginning at the point of union with the plant and gradually working inward. Tubers in which the rot is well advanced may be mashed and smeared over the sound tubers and thus spread the disease. Very slightly infected tubers are frequently overlooked by the cutters. Usually plants from diseased seed pieces will die before the tubers have reached a market size. The use of certified northern seed and home-grown second-crop seed has caused a very great reduction of this disease in New Jersey during the past 6 years.

Control.—Throw out all seed tubers that show evidence of the disease. Treat the seed with formaldehyde or corrosive sublimate (see pages 33, 34).

COMMON SCAB

This is one of the most common and best known of the potato diseases, and yet one which is very generally neglected by the growers. It is caused by *Oospora scabies* Thaxt. (*Actinomyces chromogenus* Gasparini), and varies from a very slight russeting to pronounced roughness (fig. 4). In extreme cases the tubers are small and the roughness takes the form of holes, which are frequently one-sixteenth to one-fourth of an inch deep.

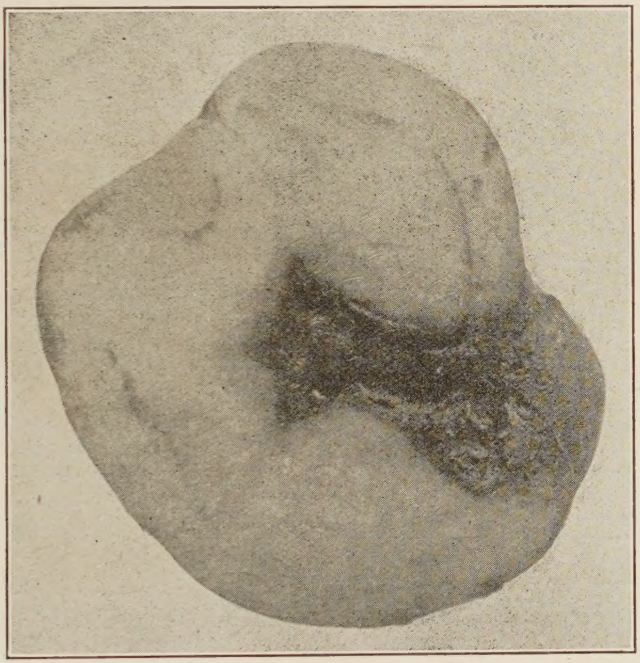

FIG. 3. TUBER ROT, DUE TO BLACK LEG
(From Farmers' Bulletin 544, U. S. Dept. of Agriculture.)

The organism causing this disease can be carried on the seed, in the dust on healthy tubers, and in manure from animals fed on diseased tubers; it will also persist in the soil. It is most severe in alkaline soils, and growers should therefore avoid the use of lime, wood ashes, soda, and stable manure on potato lands unless applied with other crops in rotation. The disease also occurs on beets, turnips and some other plants.

Control.—(a) Select smooth seed, (b) disinfect with formaldehyde or corrosive sublimate (see page 33), (c) plant in clean soil following a green crop, (d) avoid alkaline fertilizer, (e) do not plant on infected soil for three to five years, (f) do not use beets or turnips in the crop rotation, (g) in severe cases treat the soil with sulfur (page 35).

POWDERY SCAB

This disease is quite different from the common scab, but resembles it somewhat. It is caused by a slime mold (*Spongospora subterranea* Wallr., Lag.), and was probably introduced

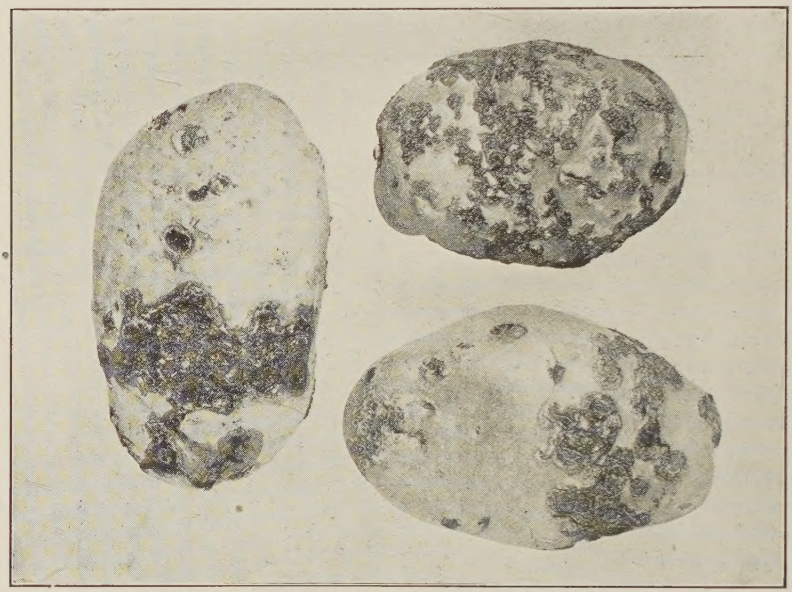

FIG. 4. COMMON SCAB

from Europe. The spots are covered when young, but when mature break into brownish, powdery masses. It is difficult for the inexperienced person to distinguish this disease from the common scab. The most pronounced characters are a more or less regular arrangement of the spots in rows, a peeling back of the skin around the spots and the reddish powder or spores within the cankers. It is said to be a very serious disease in Europe. It is now known to exist in Canada, parts of Maine and New York, and possibly in some other parts of the United States. Observations and experiments conducted in 1915 and 1916 indicate that it is not likely to prove serious in New Jersey and points farther south. Thus far no satisfactory method of seed treatment has been devised.

POTATO WART

This is one of the most important European diseases. It is caused by a fungus (*Chrysophlyctis endobioticum* Schib.), and is extremely difficult to control. It has been introduced into Newfoundland. On the severely affected tubers it causes coral-like, scaly nodules, which are readily recognized (fig. 5). Seed potatoes may be so slightly affected that it is very difficult to detect the disease. These slightly infected tubers are most dangerous for seed purposes. The danger of the introduction of this disease has been greatly reduced by the quarantine which the United States Department of Agriculture has placed on all foreign countries in which it is known to exist, and it was sup-

FIG. 5. POTATO WART

(From Photo by Prof. J. G. Saunders, Economic Zoologist of Pennsylvania.)

posed that we had prevented its introduction into this country. Unfortunately it was introduced on table stock previous to this quarantine, and it has been recently found in the vicinity of Freeland, Luzerne County, Pennsylvania, where it is proving very destructive. Fortunately this infected district does not produce potatoes for market purposes and the disease is confined to gardens and small plantings for local consumption. The entire district has been quarantined, and it is probable that the disease will be eradicated. *Be careful as to the source of your seed potatoes. Keep this disease out of New Jersey.*

SCURF OR RHIZOCTONIA

This widely distributed disease occurs in several different forms and is known under correspondingly different names as "scurf," "brown stem," "Rhizoctonia," "little potato," "aerial potatoes," "rosette" and "stem rot." The disease is caused by the fungus "Rhizoctonia," or *Corticium vagum* B. & C. var. *solani* Burt. This disease is more or less abundant every year, but was especially severe in 1915. It is most severe on sandy soil. It is probably the cause of greater losses than are attributed to it. Some of the symptoms are common to other diseases and this, no doubt, frequently leads to some confusion. The diseased

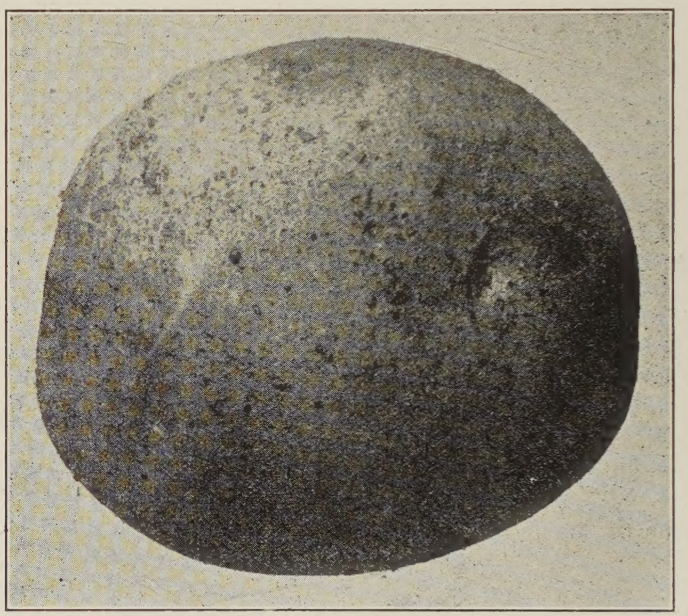

FIG. 6. TUBER COVERED WITH SCURF SCLEROTIA

tubers show small black spots (sclerotia) which do not wash off, but which can be readily scraped off with the finger-nail (fig. 6). These small black spots are the resting stage of the fungus. It is by means of these sclerotia that the disease is carried over from year to year on the seed tubers.

The organism may also exist in the soil, but its presence in the soil or on the potatoes does not necessarily indicate that it will prove a serious disease in the coming crop. It is undoubtedly influenced by soil, temperature, moisture or some other factors not well understood.

The disease varies in appearance and severity with varieties. The most common forms are as follows:

(a) *Poor Germination.* Some of the seed pieces fail to germinate, others produce short, thick sprouts which never break through the ground (fig. 7); others produce spindling, white sprouts which die back or produce weak plants. In the case of

FIG. 7. POOR GERMINATION RESULTING FROM RHIZOCTONIA

dying back, a second and even a third shoot may be produced (fig. 8). In case of repeated dying back, many spindling shoots may finally be produced from the seed piece.

(b) *Brown Stem* and *Cankers.* The poor germination is accompanied by a browning of the stem. This brown area frequently assumes the proportions of well defined *cankers* (fig. 9). These brown areas and cankers may be found on plants of all ages. If the fungus attacks the plants when young, the cankers are severe and the disease very destructive, but if the plants are well advanced when attacked the loss is much less.

(c) *Roll Leaf.* In the latter part of the season the tips of the young leaves tend to roll in a manner suggesting the leaf roll, but can usually be distinguished by a brownish tint. This character is especially prominent on the Irish Cobblers and similar varieties.

(d) *Little Potato.* Many small tubers are frequently produced on seriously diseased plants. We have found as many as forty-two tubers on a single plant. This phenomenon is most common on the early varieties and may be due to other causes.

(e) *Aerial Potato.* Small tubers are frequently found on the stem, in the axils of leaves, above ground. This character is usually associated with "little potato" and also may be due to other causes.

(f) *Yield.* This disease always causes a reduced yield as compared with that of healthy plants. Experimental work conducted by the writer shows that there is always a reduced yield and that in severe cases the tubers are so small as to be unsalable.

Control.—Use clean seed if possible and *always* treat the

FIG. 8. POOR GERMINATION RESULTING FROM RHIZOCTONIA

seed with formaldehyde or corrosive sublimate (see page 33). Experiments conducted on the New Jersey Agricultural Experiment Station Farm in 1915 and reports from other States show that corrosive sublimate is more satisfactory than formaldehyde. Rotation of crops should be practiced where practical.

SILVER SCURF

This is a fungous disease (*Spondylocladium atrovirens* Harz.) which was introduced from Europe a few years ago. It appears as a dark spot on the skin and in mild forms may escape the

notice of most growers. In storage, these spots enlarge, and the tubers shrivel and become somewhat silvery in appearance. This disease is quite common on seed coming into New Jersey and has also been found quite abundant in some plantings. It does not appear to be a very serious disease for New Jersey growers.

Control.—Throw out tubers that show evidence of this disease.

FIG. 9. CANKER RESULTING FROM RHIZOCTONIA

DRY ROT AND WILT

This is a very common and widely distributed fungous disease (*Fusarium oxysporum* Schlecht.) of the potato, and is frequently referred to as "Fusarium wilt" and "stem blight." It can be recognized in the tuber by the black discoloration starting at the stem and just below the peel. This disease causes a dry rot in the late summer and fall and in winter storage. In the field the diseased plants wilt and die prematurely, the stems blacken and

rot at the surface of the ground, and are frequently covered with a delicate white or pink fungous growth. When the diseased stems are cut across, the fibro-vascular bundles are found to be black and dead (fig. 10, 11).

Control.—Throw out all seed that shows black discolorations when cut. Use a five-year crop rotation for infected fields.

FIG. 10. FUSARIUM ROT

OTHER DRY ROTS

Other species of Fusarium are the causes of storage rots. Among the most important are *Fusarium trichothecioides* Wr., which causes a powdery dry rot in the western states and *F. tuberivorum* Wilcox, which causes a dry rot in Nebraska. These rots have not been reported from New Jersey.

VERTICILLIUM WILT

This is due to a fungus (*Verticillium alboatrum* Reink and Berth) and is very similar to the Fusarium wilt. The black discoloration of the tuber is much more pronounced than in the case of the Fusarium wilt and the wilting is more rapid. It is less common and not so widely distributed.

EARLY BLIGHT

This is a very common and widely distributed fungus (*Macrosporium solani* E. & M., J. & G.) which attacks both potatoes and tomatoes and is frequently the cause of heavy losses. It appears as dark, grayish spots on the leaves, within which delicate, black, concentric circles are frequently formed (fig. 12). These spots increase in size, and unite, forming irregular blotches and frequently destroying the entire leaf. The older spots become dry and brittle. Flea beetles and other insects carry the disease from

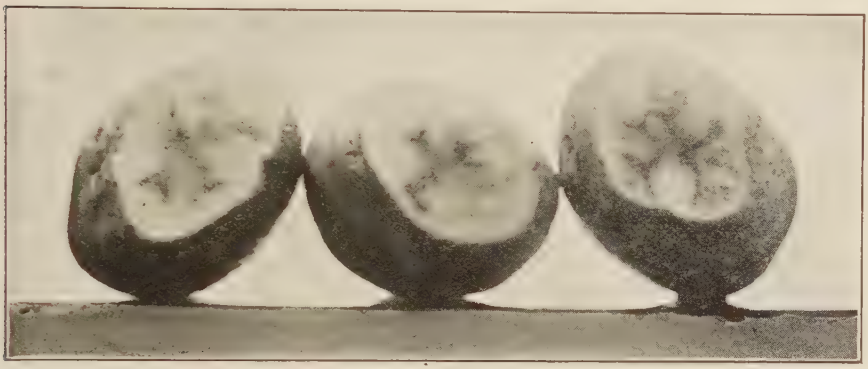

FIG. 11. CROSS-SECTION; SHOWING DISCOLORATIONS
(Courtesy of N. J. State Department of Agriculture)

plant to plant. This disease is not apt to be serious on vigorous, well-fed plants. It is usually more severe on the second crop than on the first. It is more severe on plants that have been injured by Paris green than on normal plants. It attacks plants that have been injured by tip burn, and it is frequently difficult to estimate the losses due to these two causes. It is also more severe on tomatoes than on potatoes.

Control.—Spray with Bordeaux mixture or other good fungicide (see page 17).

LATE BLIGHT

This, one of the most destructive diseases of the potato, is caused by the fungus *Phytophthora infestans* De By. It is common in northern potato-growing districts and in the mountainous districts of the southern States. The new spots on the leaves are large, appear water-soaked from above and show a whitish, sometimes pinkish, mildew growth on the lower side. When mature they become dark brown, dry and brittle. It is especially severe in cool, moist weather, frequently causing the foliage to wilt and blacken in a very few hours. It also causes a soft tuber rot in the fields and a dry brown rot in storage.

The cut surface of diseased tubers shows a rot causing a

brownish, yellowish, or marble discoloration which may originate at any point (fig. 13). Diseased tubers are more or less common in northern seed. These diseased tubers fail to germinate, or produce weak plants which give a very poor yield or die very early. *The loss due to poor germination of northern seed when planted in New Jersey is sometimes very high.* This disease is more or less common in the mountainous counties of New Jersey, but is very seldom of importance in other parts of the state. The only important outbreak of this disease in New Jersey during the past seven years was in Monmouth and Mercer counties in 1918. The loss due to this cause was relatively small.

FIG. 12. EARLY BLIGHT OF THE POTATO (*Alternaria solani*)

Control.—Throw out all infected seed, *i. e.,* tubers showing brown discolorations when cut. Spray with Bordeaux mixture or other fungicide, in the same manner as for early blight (see page 17).

TIP BURN

This disease is frequently mistaken for blight and most of the reports of blight in New Jersey are tip burn. It is much more destructive in New Jersey than either the early or the late blights. This disease is due to hot weather and is usually most severe in dry weather, but may prove very severe in wet seasons. It is frequently very severe in hot, dry weather following wet weather.

It causes the leaves to die, beginning at the tips and margins, the stems holding their normal position. It is often caused by applying a wet spray to the vines under a hot sun.

Control.—Plant on soil rich in humus and give good surface cultivation to conserve the moisture. Irrigate where possible. Spray with Bordeaux mixture in order to keep the foliage in healthy condition. Do not use a wet spray in bright sunlight.

ARSENICAL POISONING

Spotting and dying of the foliage is frequently caused by the application of Paris green or other arsenical poisons. It is frequently mistaken for blight and injures the plant in proportion as it reduces the amount of green surface. The injured foliage also offers favorable conditions for the development and spread of the early blight (see page 15).

Control.—Paris green should always be mixed with lime, whether applied dry or in water. It can be applied with Bordeaux mixture without additional lime. Arsenate of lead can also be applied with Bordeaux mixture. The latter spreads and sticks better than Paris green, but acts more slowly.

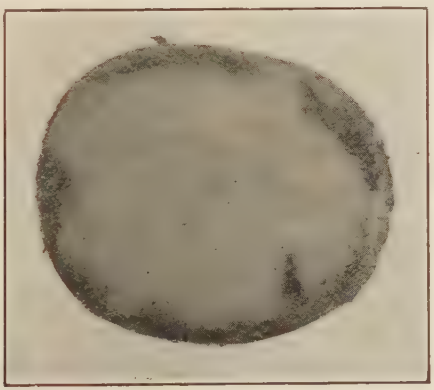

FIG. 13. LATE BLIGHT DRY ROT
(From Farmers' Bulletin 544, U. S. Dept. of Agriculture)

POTATO SPRAYING AND DUSTING

Potatoes are subject to several leaf diseases, some of which can be controlled by spraying. A great deal of experimental spraying has been carried on in the potato-growing districts of the country, and a great deal has been written on the subject. In some localities, especially the extreme northern potato-growing districts, the results have been exceptionally good, while in other places they have been less satisfactory.

Home-made Bordeaux mixture has been the most popular spray material in the big potato-growing sections of the world ever since its efficiency in the control of late blight was established. Extensive spraying work in New York and New England has demonstrated the advisability of its use. In Maine and Vermont the increase in yield due to spraying, even in years when no blights were present, has been quite marked. In the ten years' spraying experiments by the New York Experiment Station, the average increase due to Bordeaux sprayings at Geneva was 97.5 bushels per acre for 5 to 7 sprayings per annum and 69 bushels per acre for but 3 sprayings. On Long Island the increase in yield due to spraying was not so large. An average annual increase of 45.7 bushels per acre was brought about by five to seven sprays and only 25 bushels per acre from three applications of spray. However, it is well known that spraying on Long Island does not give profits every year.

COMPARISON OF FOLIAGE DISEASES

Early Blight	Late Blight	Tip Burn	Arsenical Burns
Caused by a fungus	Caused by a fungus	Caused by weather conditions	Caused by arsenical poisons
Very common in New Jersey	Rare in New Jersey	Very common in New Jersey	Common in New Jersey
Most abundant on late crop	May appear at any time weather is favorable	Any time after the middle of June	Any time during growing season
Starts as small black spots which enlarge	Starts as large water-soaked spots	General dying and drying of leaves but no spotting	Similar to tip burn but less extensive
Spots within the leaf	Spots on tips and margins of leaves		
Spots become dry and frequently show delicate target circles	Spots show delicate white or pinkish growth on lower side; become brown and dry		

Of course, our New Jersey potato growers know that the growing of potatoes in New England and New York is quite a different proposition from potato growing in New Jersey. It is very generally recognized that the soil, climatic conditions and disease problems are quite different. In fact, the New Jersey conditions are quite different from those of Long Island, and the conditions in different parts of New Jersey show correspondingly great variations. It is the opinion of the writer that the results of spraying in one part of New Jersey cannot be taken as a guide for potato spraying in other parts of the State.

Potatoes are sprayed for three purposes: (1) to control the foliage diseases, such as late blight (page 15), early blight (page 15), tip burn (page 16); (2) in the case of Bordeaux mixture, for the stimulation of plants; and (3) for the control of

FIG. 14. SPRAYING ON MINCH BROS.' FARM WITH TRACTOR SPRAYER, BRIDGETON, N. J.

(Courtesy of N. J. State Department of Agriculture)

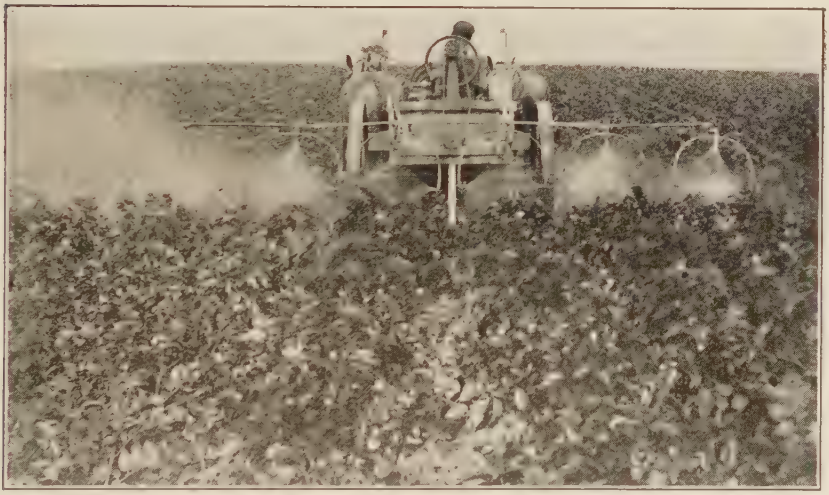

FIG. 15. SPRAYING ON MINCH BROS.' FARM, BRIDGETON, N. J., WITH POWER SPRAYER, USING GASOLINE ENGINE. THIS FIELD OF POTATOES WAS GROWN FROM LATE-CROP COBBLER SEED, GIVING A YIELD OF OVER 100 BARRELS PER ACRE OF PRIME POTATOES

(Courtesy of N. J. State Department of Agriculture)

insects. Keeping these three points in view, let us consider what can be expected in New Jersey. (1) Late blight is not of very great importance as a leaf disease in New Jersey. During the past 7 years we have had only one serious outbreak of this disease in the state, and that was in Mercer and Monmouth counties in 1918. Even when this disease is prevalent on Long Island it can seldom be found in New Jersey. (However, it does injure germination, as described on page 16). Early blight starts early in the season and increases in severity until frost. It is especially severe following severe cases of tip burn. It is always prevalent in New Jersey, is the cause of more or less loss and can be held in check to some extent by Bordeaux spraying. (2) It is very generally believed that Bordeaux mixture stimulates plant growth and causes increased yield, but there are some differences of opinion on this point. (3) The spraying for the control of insects belongs to the Department of Entomology, and is an entirely different problem from the spraying for diseases. However, the presence of insects complicates the disease problem, in that insects are frequently the carriers of the organisms causing the diseases. This publication has nothing whatever to do with the control of insects.

In 1913 the New Jersey Agricultural Experiment Station took up the problem of potato spraying, fully realizing that under the various New Jersey conditions it would be necessary to carry this work on for a number of years and in different parts of the State. A summary of the past 6 years' work will be presented at this time but the work will not be discontinued. In 1913 experiments were carried on by the senior author and Mr. G. W. Martin, in the 1914 experiments Dr. Headlee cooperated and Mr. A. E. Cameron had charge of the field work, the 1915 and 1916 experiments were conducted by the authors, 1917 experiments by the senior author assisted by Mr. R. F. Poole, and the 1918 experiments by the senior author and Dr. L. M. Massey cooperating. We were also assisted by some of the county agents of the counties in which the work was conducted. It is not the wish of the author to draw definite conclusions at this time. The work must be carried farther. A summarization is given in the following three tables, which the growers can study and from which they can draw their own conclusions.

Table 1 summarizes the 6 years' result with Irish Cobblers.

TABLE 1

RESULTS OF SIX YEARS' SPRAYING EXPERIMENTS OF IRISH COBBLERS
(EXPRESSED IN BUSHELS PER ACRE)

SPRAY	1913 J. Harry Kandle, Salem County	1914 J. Harry Kandle, Salem County	1914 R. M. Dilatush, Mercer County	1915 J. Harry Kandle, Salem County	1915 John Black, Burlington County	1915 J. C. Brown, Middlesex County	1916 J. Harry Kandle, Salem County*	1916 J. Harry Kandle, Salem County**	1916 John Black, Burlington County	1916 Edward Windsor, Monmouth County	1916 J. C. Brown, Middlesex County	1917 T. M. Applegate, Middlesex County	1917 J. Harry Kandle, Salem County	1918 J. Harry Kandle, Salem County	1918 D. Budd Jones, Salem County
	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.	bu.
Bordeaux + Paris Green,	315	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Kil-Tone,	299	...	...	395	...	...	385	388	...	...	...	...	316	294	...
Pyrox,	327	...	...	...	...	...	373	370	192	228	...	...	...	...	...
Arsenate of Lead,	340	213	...	394	249	214	369	384	231	258	208	175	313	271	237
Bordeaux and Arsenate of Lead,	...	276	290	389	288	206	307	378	235	276	213	178	309	294	228
Sulfur and Lead Arsenate Dust,	...	234	...	...	274	...	373	375	...	230	214	...	...	...	...
Sulfur, Gypsum Lead Arsenate Dust,	...	...	...	...	...	...	...	...	208	...	...	...	...	...	...
Sulfur, Zinc Arsenite,	...	...	240	...	296	...	...	...	...	...	...	...	...	...	...
Gypsum and Zinc Arsenite,	...	...	249	...	...	...	...	...	...	...	...	...	...	...	...
Tonicide,	...	...	...	...	255	...	...	...	...	...	...	...	...	...	...
Paris Green,	...	...	...	...	...	...	...	...	191	...	...	...	...	...	...
Lime Sulfur,	...	...	...	...	...	...	366	384	...	...	...	...	...	...	...
Hydroxcide,	...	...	...	...	...	...	...	...	230	...	...	...	...	...	...
Tuber Tonic,	...	...	...	...	...	...	330	371	203	...	...	...	...	...	...
Sulfur and Arsenate of Lead, wet,	...	...	...	...	...	...	...	...	...	...	200	...	...	...	...
Arsenate of Lead, double amount,	...	...	...	...	...	...	...	...	...	...	...	...	...	327	...
Adheso,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	224
Tiger Brand Bordeaux Lead,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	217

It will readily be seen (1) that arsenate of lead gave the best results on the J. Harry Kandle farm in 1913 and on the J. C. Brown farm in 1915 and on the D. Budd Jones farm in 1918; (2) that Bordeaux mixture gave the best results on the J. Harry Kandle and the R. M. Dilatush farms in 1914, the John Black and Edward Windsor farms in 1916, the T. M. Applegate farm in 1917; (3) that double the amount of arsenate gave the best results on the J. Harry Kandle farm in 1918; (4) that Kil-Tone gave the best results on the H. Harry Kandle farm in 1915 and 1916 (two tests) and again in 1917; (5) that sulfur and zinc arsenite gave best results on the John Black farm in 1915; (6) that sulfur and arsenate of lead dust gave the best results on the J. C. Brown farm in 1916.

Taking Bordeaux mixture, which is the standard spray mixture for the northern potato-growing districts, plus the arsenate of lead for the control of bugs as compared with arsenate of lead only, we find that it gave the following results.

TABLE 2
RESULTS OF EXPERIMENTS USING ARSENATE OF LEAD ONLY AND ARSENATE OF LEAD PLUS BORDEAUX MIXTURE
(EXPRESSED IN BUSHELS PER ACRE)

YEAR	Experiment No.	Treatment		Gain	Loss
		Arsenate of Lead	Bordeaux Mixture + Arsenate of Lead		
		bu.	bu.	bu.	bu.
1914, ...	1	213	276	63	..
1915, ...	2	394	389	..	5
1915, ...	3	249	288	39	..
1915, ...	4	214	206	8	..
1916, ...	5	369	307	..	62
1916, ...	6	231	235	4	..
1916, ...	7	258	276	18	..
1916, ...	8	208	213	5	..
1917, ...	9	175	178	3	..
1917, ...	10	313	309	..	4
1918, ...	11	271	294	23	..
1918, ...	12	237	228	..	5

Judging from the twelve tests given above we find (1) that no. 2, 10 and 12 gave slight losses; (2) that no. 4, 6, 8 and 9 gave very slight gains which were not sufficient to pay the difference in cost; (3) that no. 7 and 11 gave gains only slightly in excess of probable cost; (4) that no. 1 and 3 gave good gains; and (5) that no. 5 gave a loss practically equal to the highest gain.

The experiments recorded in table 3 were all conducted in Monmouth County and with American Giants, although Mr. Windsor's crop was grown under the name of Aroostock Prize, which is the Aroostock County name for Giant. These tests are not sufficient for comment.

TABLE 3
RESULTS OF SPRAYING AMERICAN GIANTS
(EXPRESSED IN BUSHELS PER ACRE)

	1914	1915	1916
	F. P. Jones	F. P. Jones	Edward Windsor
	bu.	bu.	bu.
Arsenate of Lead,	283	...	377
Bordeaux and Arsenate of Lead,	286	411	367
Sulfur, Gypsum and Lead Dust,	278	429	...
Paris Green,	...	403	...
Kil-Tone,	...	408	348
Sulfur and Lead Arsenate,	...	...	355
Sulfur and Zinc Arsenate,	...	403	...

The experiments which are recorded in table 4 were conducted with second-crop Irish Cobblers on the J. Harry Kandle Farm, in Salem County. These tests are not sufficient for comment.

TABLE 4
RESULTS OF SPRAYING SECOND CROP OF IRISH COBBLERS
(EXPRESSED IN BUSHELS PER ACRE)

	1915	1916	1917	1918
	bu.	bu.	bu.	
Bordeaux plus Arsenate of Lead,	248	163	217	...
Arsenate of Lead,	236	151	...	...
Sulfur, Lead Arsenate,	218	158	...	...
Sulfur, Zinc Arsenite,	229	...	...	...
Kil-Tone.	...	164	224	...
No Treatment,	...	154	210	...

Growers who wish to spray potatoes with Bordeaux mixture plus arsenate of lead should begin spraying when the plants are 4 to 8 inches in height. Spray often enough to keep the

foliage well covered. In order to do this it will be necessary to apply at least 100 gallons per acre with a pressure of not less than 100 pounds. The plants should be sprayed 4 times if possible.

Complete directions for the preparation of Bordeaux mixture are to be found in Circular 48 of this station. A detailed report of the dusting and spraying work of the station is contained in the annual reports from 1913 to 1918, and in Circular 42.

Those who wish to use commercial preparations should follow the printed rules and recommendations of the manufacturers.

FIG. 16. POTATO LEAF ROLL

Insecticides, such as Paris green, arsenate of lead, and Black Leaf 40, can be mixed with Bordeaux mixture without injury to any of the materials involved.

LEAF ROLL

The cause of this disease is not definitely known. It was much more severe in 1915 than in previous years and has been the cause of heavy losses since that date. It is carried in the tubers. It can be detected on the younger plants by a rolling upward of the margins of the lowest leaves which are also somewhat thicker and more leathery than normal leaves. The tips of the leaves are frequently lighter in color than normal leaves and die earlier (fig. 16). The older plant is usually, but not necessarily, smaller than the normal plant; the leaves are likely to be smaller than the normal, the color lighter and the entire plant bushy in character. In these large plants the upper and sometimes all the leaves may roll. The plants do not show cankers as in the case of Rhizoctonia. The yield is very greatly reduced.

Control.—Use seed from healthy plants.

FIG. 17. CURLY DWARF

MOSAIC

This disease is also of unknown cause, but is carried in the seed. The leaves are crinkled and the edges frequently turned down. They are irregularly mottled with a darker green than the healthy plants and raised somewhat higher than the yellow spots. In severe cases the plants may be dwarfed. The yield may be reduced by from 10 to 80 per cent. The disease is especially severe on Bliss, Green Mountain and Giants.

Control.—Use seed from healthy plants.

CURLY DWARF

This disease is also of unknown cause, but is believed by many to be an advanced stage of the mosaic. It is characterized by a pronounced dwarfing of the plant and foliage (fig. 17).

The leaves are very dark green, very curly, tend to turn down and are very brittle. The plants die very early. The yield is practically nothing.

Control.—Use seed from healthy plants.

SUN WILT OR SCALD

This is a wilting and sometimes a burning of the young foliage. It is most common in bright hot weather following prolonged periods of rainfall. It is frequently followed by tip burn.

NET NECROSIS

This is a peculiar disease of unknown cause appearing as dark brownish zones or streaks in the tuber. These discolorations originate at the point of attachment to the vine and are sometimes mistaken for *Fusarium* or *Verticillium* wilt. The reports concerning this disease are somewhat conflicting, but there is some evidence that it can be transmitted in the seed. Very frequently it cannot be detected at time of digging but will develop in storage.

RUSSET

Russeting of tubers is characteristic of some varieties, but in smooth varieties it is frequently associated with common scab and is probably due to the scab organism. It is also very frequently associated with Rhizoctonia.

BLACK HEART

Most growers are familiar with the black color which is frequently found in tubers. It is due to overheating, usually in storage or in shipping. A temperature of 99 to 104 degrees F. for 24 hours is usually sufficient to cause this trouble.

HOLLOW HEART

This very familiar condition is due to excessive growth. It is especially common when excessive rains follow a period of drought.

SPINDLE SPROUT

This trouble is not well understood. Sprouts of this character are frequently produced by tubers which are apparently healthy so far as fungous or bacterial diseases are concerned. It may be due to degeneracy or to low vitality.

SEED SELECTION

It is very important to use good, vigorous seed if we expect to secure the best results. The seed should be from vigorous, productive plants, relatively free from disease and true to name. A weak plant may produce one or two fair-sized tubers, and the grower who buys his seed from other localities, in most cases, has no way of knowing the character of the plants from which his seed was harvested. Neither has the grower any way of knowing the prevalence of other diseases of the potatoes on the seed producer's farm. All growers know the difficulties arising from seed containing more than one variety.

During the past few years some of the seed-producing states have endeavored to overcome these difficulties by a system of inspection and certification.* Growers wishing to improve their seed, enter their fields for certification in a manner provided by the state officials in charge of the work. The fields are inspected during the growing season, at about the time of blooming, and again as late as possible before the dying of the plants. The crop is inspected a third time, after digging, for diseases which do not show on the parts above ground. These crops must conform to a certain standard of vigor, freedom from disease and trueness to type in order to be certified. Such seed is sold in sealed bags and carries a certificate of inspection. The expense of the inspection is borne by the grower. Therefore, the cost of the seed to the New Jersey buyer is slightly increased, but the increased yield resulting from the use of such seed should more than compensate for the added cost.

Proper inspection and certification tends to reduce not only the amount of potatoes not true to type, but also many diseases, such as common scab, blackleg, black scurf, mosaic and leaf roll. It also reduced the number of weak plants. The results from the use of northern certified seed have been very encouraging.

NEW YORK CERTIFICATION

In New York the inspection and certification are under the supervision of the New York State Potato Association. The inspectors are appointed by the president upon recommendation of the department of plant pathology of the State College of Agriculture. Their salaries and expenses are paid by the association. A tax sufficient to cover the expenses of this inspection and certification is levied on the growers who make use of it.

* Growers should not confuse the certified seed referred to above with the United States Government inspection of 1913 to 1915. This inspection was for powdery scab only, and gave no consideration whatever to other diseases, vigor or trueness to type. It has been discontinued.

All applicants for registration must pay a fee of $2.00, and in case a certificate is issued, an additional fee of 1½ cents per bushel is charged for all potatoes sold under the certificate. All shipments of certified seed must be made in new bags, holding 165 pounds each.

The inspectors make three inspections as follows: (1) when the potatoes are in bloom, (2) as late as possible before the dying of the plants, and (3) after digging.

Fields may be disqualified for the following reasons:

(1) The presence of more than 15 per cent of mosaic at the first inspection or of more than 5 per cent at the second inspection.

(2) The presence, at the first inspection, of more than 10 per cent of any one of the following diseases: wilt, black leg, leaf roll, curly dwarf or hills weak from other causes; or of more than 15 per cent of all combined.

(3) The presence, at the second inspection, of more than 1 per cent of any one, or of 3 per cent of all combined, of the diseases named in (2).

(4) The presence of more than 15 per cent of varietal mixture at the first inspection or more than 1 per cent at the second inspection.

(5) Infestation with early blight, late blight, Colorado beetles or flea-beetles to such an extent as to make identification of other diseases difficult.

The certificate is as follows:

CERTIFICATE OF POTATO SEED INSPECTION No. —
New York State Potato Association

.....Pres. .....Sec.
Kasoag, N. Y. Ithaca, N. Y.

This certifies that the potato fields and seed-stock of.....

.....

have been inspected by a representative of the Association and have been found to conform to the standards set by the Association (see reverse side) for seed-stock as regards varietal purity and freedom from disease.

This certificate applies only to the fields inspected and found to conform to these standards. The holder is responsible for conditions developing after the last inspection is made.

This certificate is given only after the grower has made a signed statement that he has fulfilled all the requirements made by the inspector and that he has done, or will do, before shipping, the necessary grading and sorting.

The Association reserves the right to revoke this certificate at its discretion.

The conditions found to exist in the stock covered by this certificate are shown in the inspector's report attached hereto.

(Reverse side of certificate)

Standards of New York State Potato Association for certified seed potatoes:

Freedom from varietal mixture.

Conformity to type of variety as regards vine and tuber characters.

Freedom from wart and powdery scab.

Practical freedom from leaf roll, curly dwarf, black leg and weak hills.

A maximum of 5 per cent mosaic.

Freedom from serious infection with other diseases. (The amount of such infection to be stated in the certification.)

Tubers to weigh between 2 and 12 ounces for late varieties and between 2 and 10 ounces for early varieties.

Good cultural methods.

Satisfactory yield for the variety and season.

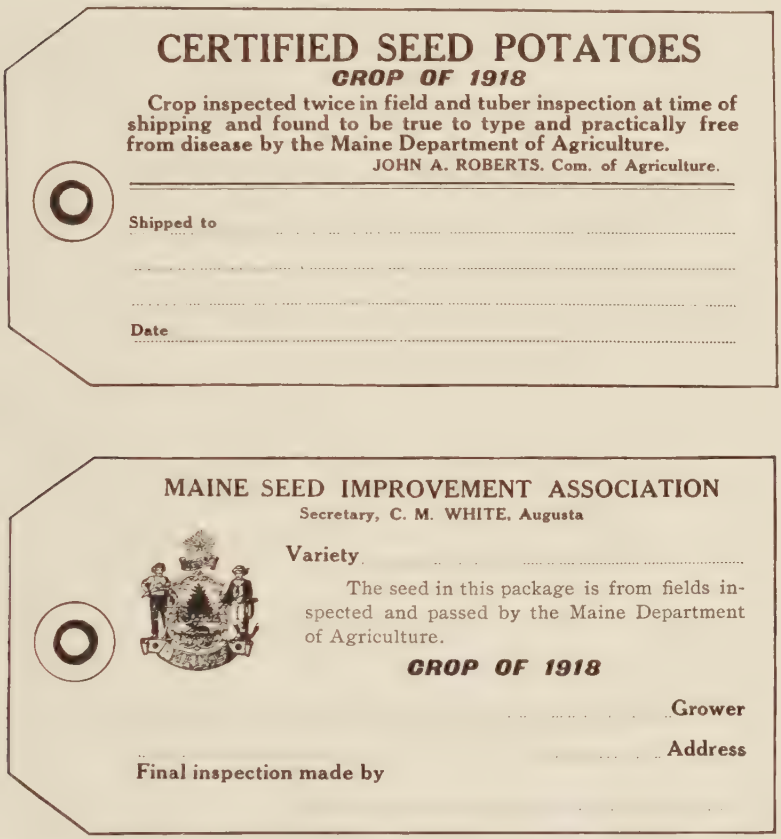
CERTIFIED SEED POTATOES
CROP OF 1918
Crop inspected twice in field and tuber inspection at time of shipping and found to be true to type and practically free from disease by the Maine Department of Agriculture.
JOHN A. ROBERTS. Com. of Agriculture.
Shipped to
Date
MAINE SEED IMPROVEMENT ASSOCIATION
Secretary, C. M. WHITE, Augusta
Variety
The seed in this package is from fields inspected and passed by the Maine Department of Agriculture.
CROP OF 1918
Grower
Address
Final inspection made by

FIG. 18. BLUE TAG USED IN SEED CERTIFICATION IN MAINE (THE DIAGRAMS ARE REPRODUCTIONS OF BOTH SIDES OF THE TAG)

MAINE CERTIFICATION

In Maine the inspection and certification is under the supervision of the Maine Seed Improvement Association and the Department of Agriculture. The grower pays 50 cents per acre to make an entry, and $1.00 per acre for each of the two field inspections, making the total field inspection cost $2.50 per acre.

At shipping time there is a further charge of 5 cents per sack, and the tag is attached to the sack or barrel by one of the Department inspectors. The *blue tag* is shown in figure 18.

The requirements are as follows:

The seed shall be carefully selected and all potatoes showing disease shall be thrown out. There will be a greater probability of the crop passing inspection, if the seeds tubers are soaked, before being cut, in a solution of corrosive sublimate—4 ounces in 30 gallons of water—for one and one-half hours. Three inspections will be made. At the first inspection, made at blossoming time, the field will be carefully rogued for black leg, mixed types and weak plants. If more than 80 hills per acre of black leg, 240 mixed hills or 500 weak hills are found, the field will be disqualified for the certificate. At the second inspection which will be before digging and, if possible, before the plants ripen, over 16 hills of black leg per acre will disqualify or 80 hills of other varieties per acre. A fair sample shall be dug from the field at this time and if more than 5 per cent of the sample dug show great weakness in yield over the rest of the sample dug, the field will be disqualified for certification.

Note will be made of all diseases found and will be reported by the inspectors to the Department of Agriculture and the Association. A third inspection shall be made before awarding the certificate and the general quality of the tubers noted. No diseased or badly damaged potatoes shall be sold as certified seed stock and no potatoes under-size or over-large for the variety. If powdery scab is found, the certificate shall not be awarded, nor if leaf roll or a large number of hills affected with wilt disease be found. Except in very bad cases, late blight will not disqualify.

FIRST INSPECTION

Name of Grower .....
Address .....
Varieties and acreage of each .....
.....
General appearance of fields .....
.....
Blackleg: Note number of hills found in each variety .....
.....
Varietal Mixtures: Note each hill which is noticeably of different variety...
.....
Weak Plants: Note number found in each variety, including Curly Dwarf, Mosaic and Wilt .....
.....
Leaf Roll: If found note its appearance.....
Does grower agree to follow inspector's recommendation in regard to caring for weak plants and varietal mixtures?.....
In case of doubt, send samples to Dr. W. J. Morse, Plant Pathologist, Maine Experiment Station, Orono .....
Date.....

.....
Inspector.

SECOND INSPECTION

Name of Grower .....
Address .....
Varieties and acreage of each .....
.....
General appearance of fields .....
Number of plants of other varieties .....
Number of blackleg hills .....
Number of Rhizoctonia hills .....
Number of weak plants, including Curly Dwarf, Mosaic, Wilt, etc. .....
Number of plants of leaf roll .....
Is late blight prevalent in fields? .....
Is yield uniform in each variety? .....
(Note.—Dig sufficient hills on each field to get average,)
Approximate average weight of tubers in hill, each variety .....
.....
Are tubers smooth, uniform and of good shape, each variety? .....
Powdery Scab .....
Notes of interest .....
.....
Date..... .....

Inspector.

INSPECTION AND CERTIFICATION IN OTHER STATES

Vermont, Wisconsin and some other States have regulations governing the inspection and certification of seed potatoes. The great bulk of the seed used in New Jersey comes from Maine and New York, and, therefore, we have given the regulations from these States only. Those interested in securing seed potatoes from other States can very readily secure the necessary information concerning inspection and certification by writing to the State authorities of the States from which they wish to purchase the seed.

HOME-GROWN SEED

The growing of the "second-crop seed" has been practiced in New Jersey and other states for many years. This method consists of holding northern seed in cold storage and planting early in July. The crop thus produced is held until the following spring and planted for the early crop. Field studies show that it matures from ten days to two weeks later than the crop from northern seed, that there are fewer missing hills and much less of certain diseases, especially black leg. This freedom from disease is very readily explained. We have previously stated that northern-grown seed infected with black leg and late blight fails to grow, or produces weak plants which do not bear tubers; therefore, these diseases are almost or entirely eliminated in a single planting. The increase in yield over the northern seed is largely due to this lack of missing and diseased plants. Some growers hold a small amount of the second crop seed for late planting and thus continue the growing of home seed from year to year.

We do not have enough experimental data to determine to what extent New Jersey can grow her own seed and to what extent she must remain dependent upon northern seed-producing States, but the growing of "second-crop seed" is undoubtedly profitable for the South Jersey grower of the Irish Cobbler.

HIGH-GRADE SEED

The very best grade of seed potatoes is none too good for New Jersey growers. How shall we secure them? It is very evident that there is a great difference in seed potatoes and it appears that certified seed and other seed which has been grown under supervision gives uniformly good results.

The New Jersey grower should know something about the origin of his seed. If possible he should know the name of the northern grower. It is to be hoped that the time is not far distant when all seed potatoes will be shipped in bags, each bag bearing the name of the grower. Seed shipped in bulk and without the name of the grower may be a mixture of good and bad seed from different farms. The New Jersey farmer gets a mixture, or one farmer gets a maximum of the good seed while his neighbor gets a maximum of the poor seed at the same price.

Having used great care in securing good seed, the New Jersey grower should use every possible precaution in handling it. It should be protected from frost and over-heating; should not be handled roughly; should be treated with formaldehyde or corrosive sublimate; carefully inspected during cutting; treated with sulfur or land plaster; properly planted, cultivated and protected from insects and fungous diseases.

SEED TREATMENT

It has been demonstrated that it is advisable to treat the seed with formaldehyde or corrosive sublimate for scab, black leg and scurf (Rhizoctonia). The fact that these diseases sometimes appear on crops grown from treated seed is not an argument against the treatment. Repeated experiments in many parts of the country prove the advisability of treating the seed. It should be done by the grower.

The most satisfactory method of using FORMALDEHYDE (Formalin) is to mix one pint (or pound) of the commercial 40 per cent solution in 30 gallons of water and soak the potatoes for 2 hours. This is most easily accomplished by partly filling sacks with potatoes and putting them in the barrels containing the mixture. The mixture can be used eight or ten times. It is not dangerous to handle but it causes an irritation of the eyes and the nose. *Always spread the treated seed in a thin layer so*

that they may dry as rapidly as possible. Too long an exposure to the liquid will injure the germination. It is best to give the treatment before the seed sprouts. The treatment will kill most of the sprouts that may be started at the time, but good seed will produce new sprouts.

CORROSIVE SUBLIMATE solution is also an excellent treatment for scab on seed potatoes and is more effective against the scurf (Rhizoctonia) than the formaldehyde. Mix 4 ounces of corrosive sublimate in 30 gallons of water and soak the potatoes for 1½ hours. Caution: *Do not mix the solution in a metal container. Corrosive sublimate is a deadly poison, and must be kept out of reach of children and irresponsible persons. The mixture can be used four or five times.*

NOTE: Recent experimental work carried on by Dr. G. H. Coons, of Michigan Agricultural Experiment Station, gave the following results: (a) Soaking in formaldehyde for 15 minutes was as efficient as soaking for 1½ hours. (b) Soaking in corrosive sublimate for ½ hour or for 1½ hours controlled both common scab and black scurf; when the solution was heated to 130° F. soaking for 5 minutes was sufficient. (c) Soaking with corrosive sublimate for 1½ hours gave a poorer stand than the ½-hour treatment; the hot corrosive sublimate treatment also gave a poor stand.

The cutters should use two knives; one should be kept in a cup of formaldehyde (1 part to 19 parts water) while the other is in use. These knives should be changed frequently and always immediately following the cutting into a tuber showing discolorations, rots or other evidence of disease.

All tubers showing discolorations, rots and other internal evidence of disease should be thrown out.

The practice of dusting cut potatoes with sulfur, gypsum, slaked lime, etc., is quite common among many of the growers in the State. The use of any of these materials results in the more rapid formation of an artificial skin, thus reducing the amount of water lost from the seed piece. Of these materials the sulfur is probably the better, since its fungicide properties are more marked.

METHODS FOR SOIL TREATMENT

Even before the organism causing potato scab had been isolated, experiments had been conducted in which many substances were introduced into the soil for the purpose of controlling the disease. With the discovery of the organism, the work with soil fungicides was resumed in a more intelligent manner until to-day we have a considerable amount of accurate data.

Many of the substances tried have been found partially effective but too expensive for commercial practice, others have been found worthless, and others even tend to increase the scab. The influence of some of the more common materials applied to the soil for the control of scab may be summarized as follows:

Barnyard Manure—Much work has been done upon the influence of barnyard manure upon potato scab with the almost invariable result that the amount of scab is materially increased. Fresh manure is apparently more likely to be injurious than old or composted manure. In general, the higher the rate of application, the greater the amount of scab. There can be little doubt that applications of manure should be made on the other crops in the rotation, rather than immediately before or on the potatoes.

Scabby Potatoes Grown on Limed Plot — Clean Potatoes Grown on Adjoining Unlimed Plot

FIG. 19. EFFECT OF LIME ON POTATOES

Lime—This material likewise has been found to favor the development of scab, and applications of lime are not to be recommended on the potato crop (fig. 19). The tendency of potato soil to become acid and the difficulty of obtaining a good catch of clover for a cover crop upon such soils, makes the application of lime necessary at some place in the potato rotation. The best time to apply lime in a potato rotation is immediately after the crop is dug.

Wood Ashes—This material is but little used at present, and there is little doubt that it is favorable to the development of scab to a marked extent.

Other chemicals, such as acid, kainit, sulfate of ammonia, make the soil acid, or sour, and tend to inhibit the scab organism and thus reduce the amount of scab.

Sulfur has been used in a variety of ways under a number of different conditions to destroy potato scab. The results have not always been satisfactory. Therefore, the New Jersey Agricultural Experiment Station has recently conducted experiments* over a period of 4 years. The following statements are based on the results of this work.

The experiments have all been of the field type, conducted in cooperation with practical growers, and all of the points tested have a practical bearing upon the ordinary methods used in growing potatoes. The influence of these various factors will be taken up separately.

As stated previously, any material that tends to render the soil acid makes conditions unfavorable for the development of scab. In our experimental work we have used sulfur in various ways and amounts. When applied to the soil it is transformed to sulfuric acid, thus making the soil unfavorable to the scab organism. It is probable that other products besides sulfuric acid are instrumental also, but the reason why sulfur should be effective is readily apparent.

Presence of a Cover Crop

Practically all progressive growers in New Jersey now sow a cover crop on the soil which is to be in potatoes the following year. It was therefore considered of importance to learn to what extent the presence of a cover crop aids or interferes with sulfur in combating the scab.

The results of experiments illustrate the influence of a cover crop on the yield itself and on the efficiency of sulfur as well.

Untreated soil showed an average yield of 192 bushels per acre without a cover crop, as compared with 213 bushels per acre where a cover crop had been grown. Less scab was on the crop from the plots with a cover crop than on the plots without.

The sulfur was from two to five times more effective on soil with a cover crop than on soil without a cover crop.

---

*Work with sulfur for the control of potato scab was conducted by the late Dr. B. D. Halsted several years ago with promising results. He was one of the pioneer workers on this problem.

Time of Application

In a test of the fall application of sulfur as compared with a similar one made the following spring, it was found that the number of clean tubers was increased but 4.61 per cent from the fall application as compared with an increase of 26.91 per cent for the spring. Apparently the fall application is not to be recommended.

Rate of Application

Sulfur has been used at the rates of 300, 600 and 900 pounds per acre. The use of any quantity over 600 pounds per acre is not to be advised except under especially alkaline conditions. With most potato soils which are ordinarily acid, it will be found best to use about 300 pounds per acre. The control of scab is not so good with this quantity as with the larger amounts, but there is little if any danger attached to its use. The most rational recommendation offered as a result of this work is the annual application of sulfur at the rate of about 400 pounds per acre. When combined with seed treatment it should be possible practically to eliminate scab and at the same time do no injury to the soil, through the annual usage of 300 pounds of sulfur per acre.

Seed Treatment

From the results on this phase of the problem it appears that either the formalin or corrosive sublimate treatment results in both an increase in yield and a decrease in the amount of scab. In the experiment with sulfur this material was found more effective on the treated seed since it has only the organism in the soil to combat.

Method of Application

Four different methods of application have been tried:

(1) Broadcasting before planting, (2) broadcasting after planting, (3) applying in mixture with the fertilizer, and (4) applying on top of the potato ridge.

Of these four methods the broadcasting either before or after planting is advisable. In the experimental work broadcasting after plowing and harrowing but before planting gave the best results.

Applying sulfur in a mixture with the fertilizer is the most convenient method, but the sulfur is not so effective and a decrease in the yield quite generally results where this plan is followed.

When sulfur is applied on top of the ridge after planting the scab is controlled satisfactorily, but the yield is so decreased that this method is not recommended.

INFLUENCE OF VARIETY

Of the varieties grown commercially in New Jersey, only the Irish Cobbler and Green Mountain scab to such an extent that soil treatment need be adopted. With the Giants and other "long stock," the sulfur appeared to give a whiter skin and finer texture, but the benefits will seldom be found commercially profitable.

With the Irish Cbbler, particularly where grown on the same soil for a number of years, it will sometimes be commercially profitable to adopt the sulfur method for the eradication of scab.

INFLUENCE OF THE FERTILIZING CONSTITUENTS

For the guidance of growers who prepare their own mixed fertilizers, the following points brought out in the experimental work are of interest.

1. Nitrate of soda tends to increase scab, whereas sulfate of ammonia tends to inhibit it.
2. Acid phosphate tends to eradicate scab in the soil, whereas bone phosphate tends to increase it.
3. Wood ashes and lime leave the soil alkaline and hence favor the development of scab.
4. When sulfur is used to combat scab it will be found advisable to use sulfate of ammonia rather than nitrate of soda and acid phosphate rather than steamed bone.

The most logical method of eradicating scab as indicated by the results of three years' experimental work lies in the combined use of all the seed, soil, fertilizer and cultural treatments known to inhibit its development.

SUMMARY

1. The growing of a cover crop ordinarily tends to decrease the intensity of the scab attacks.
2. Sulfur is more effective on soil with a cover crop than on soil without a cover crop.
3. Do not apply alkaline materials such as lime, wood ashes, or steamed bone.
4. Treat the seed potatoes. Either formalin or corrosive sublimate will kill scab, but since corrosive sublimate is more effective against *Black Scurf* or *Rhizoctonia* it is preferable.
5. Sulfur quite generally cuts down on the amount of scab. Annual applications of about 300 pounds per acre would not decrease the yield or injure the crop-producing power of the soil. The use of larger amounts sometimes de-

creases the yield the following year, but in no case has any permanent injury been done to the soil.

6. The most effective way to apply sulfur is to broadcast with a lime distributor after the soil is plowed and harrowed but before planting.

DON'TS

Do not buy seed potatoes without knowing their origin and the name of the grower, if possible to obtain it.

Do not buy European potatoes for seed. They are not adapted to our soils and climate. In tests made by the U. S. Department of Agriculture with more than one hundred varieties of foreign potatoes they gave poorer yields than the best American varieties grown under the same conditions. Foreign seed is likely to carry new diseases and may increase our difficulties.

Do not allow your seed to be chilled or overheated.

Do not handle your seed roughly.

Do not neglect to treat your seed potatoes with formaldehyde or corrosive sublimate.

Do not use potatoes that show discolorations when cut.

Do not use poor seed and expect good yields.

Do not plant culls or use small seed pieces.

PUBLICATIONS ON POTATO GROWING AND POTATO DISEASES

From the New Jersey Agricultural Experiment Station:

Circular 20—Potato Growing in New Jersey.

From the New Jersey State Department of Agriculture:

Bulletin No. 4—Seed Potatoes.

From the U. S. Department of Agriculture:

Farmers' Bulletin 533—Good Seed Potatoes and How to Produce Them.
" " 544—Potato Tuber Diseases.
Bulletin 47—Lessons for American Potato Growers from German Experiences.
" 81—The Potato Quarantine and the American Potato Industry.
" 176—Group Classification and Varietal Descriptions of Some American Potatoes.
" 195—Potato Breeding and Selection.
Circular 93—The Danger of Using Foreign Potatoes for Seed.